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(71) Applicant: **VolkerWessels Intellectuele Eigendom B.V.**
3826 PA Amersfoort (NL)

(72) Inventors:
- **STURRIS, Hendrik Willem Wim**
  7681 ED Vroomshoop (NL)
- **Beltman, Gerrit**
  7681 ED Vroomshoop (NL)
- **Vincent, Michiel**
  7681 ED Vroomshoop (NL)

(74) Representative: **Assendelft, Jacobus H.W.**
Assendelfts Octrooibureau
Keukenhofdreef 20
2161 AZ Lisse (NL)

(54) BUILDING SYSTEM WITH WOODEN PREFAB MODULES

(57) Apartment building, constructed from prefab modules with a load-bearing construction of laminated wood, the modules are applied next to each other and stacked on top of each other, so that two or more floors are realised, and are equipped on the top surface in spaced locations with a separate connector (6), fixed to the wood of the construction, for vertical coupling with the above module to prevent upward movement of the above module, a pin (14) of the connector (6) projecting above the associated module which is inserted from below into the wood (4, 9) of the above module, projecting into a coupling hole (18) which opens out to the surface of the wood (4, 9) facing the inside of the module and is spaced above the top surface of the floor plate (2) and is fixed by a boss (15) relative to the wood (4, 9) of the above module.

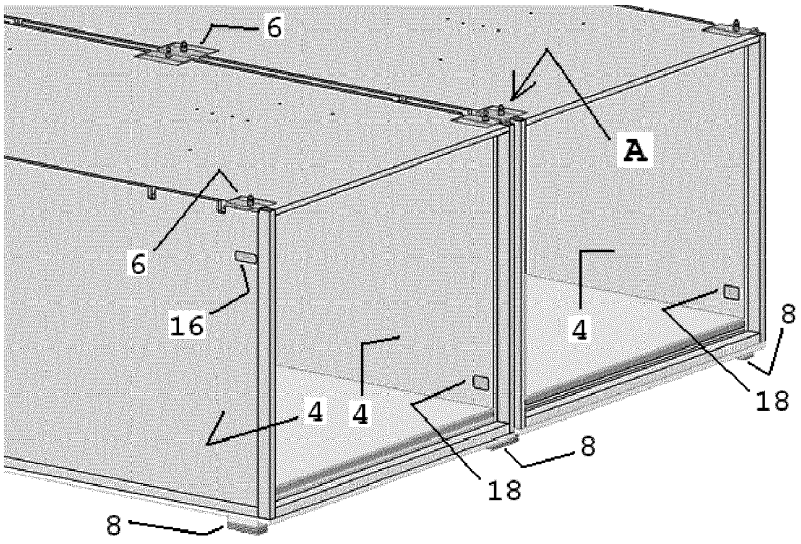

Fig. 3

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Description

[0001] The invention relates to a building system for the construction of residential areas, such as residential or non-residential construction, for example an apartment complex. The building is constructed from prefabricated modules, for example with a load-bearing construction of wood and/or wood-like material, each of which defines a spatial cell, a so-called box. The wood used for the load-bearing structure, so-called construction wood, is solid or laminated and beam-shaped, such as supporting columns and beams, and/or plate-shaped, such as plywood or OSB or HSB or CLT, also called cross-laminated wood, or LVL, and preferably soft wood or coniferous wood, for example spruce or pine. The wood layers of the laminate are preferably permanently laminated to each other by means of glue, preferably water-resistant and/or weather-resistant and/or boiling-resistant. The specific mass of the construction wood used is preferably at least 400 or 420 or 460 or 490 and/or at most 460 or 480 or 530 or 560 kilogram per cubic metre.

[0002] The plate-shaped construction wood of the floor and/or ceiling of CLT is a laminate with one or more of the following: of at least 2 or 3 or 4 or 5 wood layers; each layer of wood is at least 15 millimetre thick; the laminate is at least 60 or 70 millimetre thick for the ceiling and at least 100 or 110 millimetre thick for the floor; of the outer or surface layer on the upper and lower surface, with a thickness preferably at least 25 millimetre and/or 25% or 5 millimetre greater than other or all other wood layers, at least 80 or 90% of the wood fibres extend parallel to the width direction of the module; of at least 1 or 2 or 3 wood layers, preferably all inner wood layers, preferably all these wood layers have an equal thickness, at least 80% or 90% of the wood fibres extend parallel to the longitudinal direction of the module.

[0003] The CLT sidewall panel construction timber is a laminate preferably having one or more of the following: minimum 100 or 120 millimetre thick; consists of at least 3 or 4 or 5 wood layers; of at least two wood layers, preferably more than 50% of all wood layers, preferably of at least the outer and inner surface layer, at least 80% or 90% of the wood fibres extend parallel to the height direction of the module; of at least 1 or 2 or 3 wood layers, preferably all inner wood layers, preferably all these wood layers have an equal thickness, at least 80% or 90% of the wood fibres extend parallel to the longitudinal direction of the module; the thickness of all wood layers is minimal 15 millimetre; of at least 2 wood layers, for example the inner and outer surface layer, the thickness is at least 25 millimetre .

[0004] Here, the orientation-related terms such as "inner", "outer", "upper", "lower", "below", "top", "horizontal" and "vertical" refer to the upright usage application of the module in the building, so with the side walls vertical, the floor below and the ceiling vertically above. Dimensions given in the drawing are in millimetres.

[0005] The modules are applied next to each other, one behind the other and/or stacked on top of each other, so that at least two, three, four, five, six or seven floors or levels can be realized. One module or two or more modules next to and/or one behind the other form a living space, for example a studio or multi-room apartment.

[0006] Preferably, a module has a rectangular base, a floor comprising a floor plate and/or floor beams, and supporting columns and/or wall plates extending upwards from the floor and supporting the ceiling, comprising a ceiling plate and/or ceiling beams, of the module. The ceiling beam and/or the, preferably prismatic, supporting column, also referred to as column, is preferably of a laminated type, wherein the thickness of all wood layers is preferably at least 10 or 15 millimetre and/or of all or at least 80% or 90% of the wood layers the direction of the wood fibres extend completely or for at least 80% or 90% in the longitudinal direction of the ceiling beam or column, i.e. the longitudinal direction or the height direction of the module. Of the column, the stacking direction of all wood layers is according to the length or width direction of the module.

[0007] For example, a module is one or more of: length minimum 5 or 7.5 and/or maximum 10 or 12 or 15 metre; width minimum 2 or 3 or 3.5 and/or maximum 4 or 6 metre; height minimum 2 or 2.5 and/or maximum 4 metre; one or both end sides is sealed with end walls with windows and/or doors; one or both side walls are closed or open. The side walls preferably have a constructive function and are therefore closed. In the case of an open side wall, a non-structural filling or space separation such as a plaster wall can be present in the place of the constructive side wall, while the constructive side wall is replaced by a floor or ceiling beam at floor and ceiling level and vertical, spatially placed columns that vertically space the beams, which beams and columns provide the lateral boundary of the module. The floor and/or ceiling beam is preferably prismatic and/or continuous over the entire length of the module, i.e. without interruption in the longitudinal direction.

[0008] In the case of an open side wall, preferably one or more of the following applies on the longitudinal side of the module where the constructive side wall would otherwise be located: a minimum of 3 or 4 columns applied, with all columns having an intermediate space with the columns on either side of at least 1000 or 1500 millimetre; a column at each end of the module and one in between, e.g. half way through the length of the module and/or two in between; a column at a distance of at least 2.5 or 3 and/or at most 3.5 or 4 metre from a column at the end of the module; at the location of each column, the module is equipped with a connector and/or counter connector; the columns placed between the columns at the ends of the module keep a mutual distance of at least 2 or 3 or 4 metre. Preferably, this pattern of the connectors and/or counter connectors, for example at least eight, is also used for one or both constructive side walls of a module, so that modules with no, one or two constructive side walls can be mutually coupled vertically and hori-

zontally at will.

[0009] The outer wall of the building is preferably placed after all modules have been installed. Optionally, the modules are equipped with a facade section on one or both ends with, for example, glazing and/or access door.

[0010] Preferably, one or more of the following applies: at least five or ten modules per floor are parallel to each other; modules standing side by side and/or stacked on top of each other are aligned with each other; the support columns and/or side walls of modules stacked on top of each other are aligned; the modules are uniform and identical in size; in a stack, all modules have the same orientation in length; in the case of two or three modules standing directly next to each other, the constructive side wall is missing on the sides facing each other, so that they enclose a common space with a width equal to the combined width of the two, respectively three, modules.

[0011] Relevant prior art discloses, for example, EP2543783A1, EP2617912B1, GB1455300A, WO2013110617A1 and WO2017193179A1 and DE 10 2019 112303 A1.

[0012] The invention is set forth in the claims. The object of the invention is an improved building system of the type described in the introduction. The improvement concerns, for example, one or more of: a shorter construction time on the construction site; quickly preparing the module placed at its final location in the building on the construction site for constructive coupling with the module next to and/or above it; insensitivity to strong winds when installing the modules in the building, which ensures a quick construction time during wind, for example; a dimensional tolerance of maximum 10 millimetre in the positioning of modules placed next to each other; working safely at great heights during construction on the construction site, such as when the modules are stacked on top of each other; reliable protection against wind lifting a module from the underlying module; be able to carry out as much work as possible on the module in the factory hall; easy dismantling of the building, even after long-term use of, for example, at least 20 years, whereby all modules can be singled out without causing damage to the supporting structure and can be used individually again from a structural point of view for use in a subsequent building that is composed of individual modules next to and on top of each other. Due to the dimensional tolerance of maximum 10 millimetre , for example, considerable savings can be made on the amount of sealing compound that must be used to connect the modules tightly together.

[0013] To this end, one or more of the following improvements Nos. 1 to 5 are proposed: 1. lifting device; 2. horizontal connector; 3. vertical connector, especially anti-blowing; 4. mounting guide, such as through cone + vertical pin; 5. change from lifting bowl to cone. Preferably, the improvements 2 +3 or 2 + 3 + 4 are combined, preferably integrated, for instance at a location and/or longitudinal position on the module, and the improvement 1 and/or 5 are optionally added thereto. Preferably at least 50 or 80 or 100% of the modules of a building on the ceiling and/or floor side are in one location, preferably two or more, such as a minimum of four or six or eight, along the module length and/or or width dispersed locations, such as at the vertices and/or spaced between the vertices along the longitudinal side edges of the module, equipped with one or more of improvements 1 to 5.

1. LIFTING DEVICE

[0014] The hoisting device is a metal part and is anchored to the module by mechanical fasteners and has, for example, an upwardly projecting ball head anchor, or other point of application for the hoisting rope, which can be temporarily hooked to the hoisting rope of the hoisting crane.

[0015] Preferably, the hoisting device can be disassembled without damage, for instance by screw mounting, and /or exchangeable with an element, such as a vertical rod, for fixing adjacent modules together.

2. HORIZONTAL CONNECTOR

[0016] It is permanently mounted and preferably made of metal such as aluminium or iron or steel, preferably having one or more laterally projecting, preferably integrated, connecting lugs projecting towards the adjacent module. Preferably, one or more of the following applies: the lips are oriented horizontally; a single lip on one module side and a lip pair on the opposite module side spaced by the width of the single lip; lips such in number and positioning that with two modules legally juxtaposed, the lips of one module fit snugly between the lips of the other module; the lips equipped with mounting holes into which vertically oriented connecting pins, such as bolts, fit; the lips forming part of one or more of the hoisting facility; connector horizontal; connector vertical; mounting guide; change from lifting bowl to cone.

3. VERTICAL CONNECTOR and/or 4. MOUNTING GUIDE

[0017] Preferably, a connector is used, for instance on the ceiling side, and a counter connector, for instance on the floor side. Preferably, one or more of the following applies: the connector comprises a vertically upwardly projecting coupling pin or pin, preferably with conical base; the counter connector comprises a vertical bore, preferably conical, which opens out at the bottom surface; the position of coupling pin or pin and bore is aligned.

5. CHANGE FROM HOIST BOWL TO CONE

[0018] This is a facility, for example a hole with internal screw thread, a so-called tapped hole, for releasable attachment of a hoisting facility and/or connecting means.

[0019] Separately from and/or in combination with the foregoing, the invention preferably comprises one or more of the following aspects 1 to 9:

1. one or more of the following applies: a module is designed as a rectangular tube with closed side walls, or one or both are open, floor and ceiling of e.g. panel material, for example of wood such as CLT, so-called Cross Laminated Timber or cross-laminated timber, with a thickness eg minimum 100 millimetre; with an open side wall, vertical columns and horizontal beams are used therein; the columns are at the vertices and possibly spread between them along the length, such as halfway the length of the sidewall or in two places along the length and the beams are at the top and bottom surfaces; instead of wood, the sidewall can be made of other building material.
2. of the building, at least 50 or 80 or 100% of the modules are preferably on its top face in one location, preferably two or more locations scattered along the module length and/or width, such as at the two longitudinal edges spaced at least two or four or six or eight positions from each other, e.g. each time at the corner points and halfway along the length or at two positions along the length between the corner points, equipped with a device, hereinafter called "connector", for one or more of: lifting the module; horizontal coupling with directly adjacent module; vertically docking with the module directly above it; mounting guide with the module directly above it; changing from lifting device, e.g. lifting bowl or ball-head anchor, to mounting device, e.g. vertical coupling pin or cone with threaded rod.
3. of the building, at least 50 or 80 or 100% of the modules are preferably at its lower face in one location, preferably two or more locations scattered along the module length and/or width, such as at the two longitudinal edges at a minimum distance of two or four or six or eight positions from each other, for example each time at the corner points and halfway along the length or at two positions along the length between the corner points, equipped with a counter-provision, hereinafter referred to as: "counter-connector" preferably for cooperating with the coincident connectors of a module immediately directly below, or the foundation immediately directly below the lower module, for one or more of: horizontal coupling with immediately adjacent module; vertically docking with the module directly below; mounting guide with the module directly underneath.
4. the positions of the or all connectors of one module preferably correspond to the positions of the or all counter connectors of the module placed on top.
5. Preferably one or more of the following applies to the connector and/or counter connector: from the connector at least one or two straight locking pins extend vertically downwards over a length of at least 100 or 200 or 400 millimetre; these locking pins are received over their entire length below the connector in the wood, of plate or column, of the side wall of the module; the side wall is equipped with a vertical bore into which the locking pin is inserted; the locking pins are fixed to the wood of the module, either by bonding, chemical bonding, in the bores, or by mechanical anchoring; the mechanical anchoring is achieved by providing the side wall with a blind locking hole into which the bores open and into which the free ends, the lower ends, of the locking pins project; an oversized nut or a locking plate or the like separate thickening, larger than the diameter of the bore, is fixed on these free ends, as screwed, so that this thickening prevents the locking pin from being pulled up from the side wall; the locking hole provides access to the free ends of the locking pins for manual application of the bosses; the locking pins fixed with the wood ensure the vertical fixation of the connector with the wood of the module; a module weighing, for example, five thousand kilos can be safely suspended from the existing connectors, for example at least six, in order to be lifted by a crane to its final position in the building; after the module has been lifted to its final position in the building, the lifting device, such as the ball-head anchor, no longer has a lifting function; the hoist is modified, e.g. an upwardly projecting cylindrical stub is placed around it, which accommodates a cylindrical projection with conical lower end projecting below the lower surface of the side wall of the module to be stacked on top; the cooperation of stub and protrusion provides high accuracy of mutual horizontal positioning of modules directly stacked on top of each other; the horizontal lips of two directly adjacent modules are fixed to each other by the separate horizontal coupling plate, whereby the mutual positioning of modules placed directly next to each other is horizontally fixed; the lifting device, such as the ball-head anchor, can be dismantled and may be replaced by an alternative element, for example a coupling pin, for instance after the module has been lifted to its final position in the building; the coupling pin facilitates the process of stacking the modules on top of each other at their final location in the building and is part of the vertical mutual anchoring of stacked modules, e.g. securing against being blown up; the connector is equipped with at least one coupling pin; a straight coupling pin extending vertically straight up for a minimum length of 100 or 200 or 300 millimetre from the connector; at the free end of the coupling pin there is a separate coupling thickening; this coupling thickening is only placed after the next module has been placed on top; the coupling thickening has the same function as the locking thickening on the locking pin; the locking boss and/or the coupling boss provides a hooked edge that hooks together with the material of the side wall around the bore and is provided, for example,

by a retaining ring which is fitted snugly onto the locking pin or coupling pin, respectively, or screwed and held back by a subsequently screwed on nut; the coupling pin extends through a vertical bore in the mating connector and/or extends vertically from the mating connector for a minimum length of 100 or 200 or 300 millimetre more through a bore in the wood of the stacked module above; the connector and counter connector are located vertically one above the other in the building and optionally have a spacing of maximum 50 m or 100 millimetre, preferably, they rest directly on each other, optionally through the intermediary of an intermediate layer, for example felt or similar acoustic damping material; the coupling pin protruding vertically upwards from the connector on the top surface of the lower module is aligned with a straight vertical bore in the counter connector on the bottom surface of the module to be stacked, which bore continues vertically straight into the side wall of the module and ends in a blind coupling hole; the coupling pin of the underlying module is fixed to the wood of the module stacked on top of it, either by bonding, chemical bonding, in the bore, or by mechanical anchoring; the mechanical anchoring is achieved by providing the side wall with a blind coupling hole into which the bore opens and into which the free end, the upper end, of the coupling pin projects; an oversized nut or a locking plate or the like separate thickening, larger than the diameter of the bore, is fixed on this free end, as screwed, so that this thickening prevents the coupling pin from being pulled downwards out of the side wall; the coupling hole provides access to the free end of the coupling pin for manual application of the boss; the coupling pin fixed with the wood ensures the vertical fixation of the connector with the wood of the upper module; the bore in the female connector has a conical hole extension over a first length portion, from the lower end, to facilitate insertion of the coupling pin; the coupling pin has at its base connecting to the connector a conical boss which conforms to the conical hole extension of the bore in the counter connector, so as to fit closely together; as soon as all, for example the six or eight, coupling pins of the lower module insert into the bores in the counter-connectors of the module floating above it, suspended from the crane, the coupling pins, due to their bending stiffness, help to keep the floating module immobile in horizontal direction, which facilitates accurate stacking of the modules even at high wind speeds; the mating connector is located on the bottom face of a module; a lashing eye is provided on the counter connector to secure the module to the loading floor of a truck, for safe transport from the factory to the job site; in a blind coupling hole, a vertical, straight bore opens from below and extends vertically straight upwards from the bottom surface of the counter-connector, and thus from the bottom surface of the module, inside the side wall; in a blind locking hole, a vertical straight bore opens from above and extends vertically straight downwards from the top surface of the connector, and thus from the top surface of the module, inside the side wall; has a horizontal plate, preferably of metal such as steel, preferably with a single or double horizontal connecting lip projecting laterally from the side wall of the module and optionally one or more of: a provision, such as tapped hole, for the, optionally interchangeable, attaching a lifting bowl and/or coupling pin; at least one, two or three parallel rows of holes, for example a minimum of three or four or five per row, with a fastener, such as screw, inserted into each hole, which screws are screwed into the module and are intended to transfer horizontal forces between the modules; the gap of a double horizontal connecting lip fits exactly the single connecting lip of another connector; of two modules to be coupled side by side, one is equipped with the single and the other with the double connecting lip, mutually positioned so that the single connecting lip falls between the double connecting lip; the connecting tabs are then secured together, as screwed through the separate horizontal connecting plate; a lifting bowl with a centrally placed ball-head anchor; a threaded rod protrudes from the base of the lifting bowl, which runs in line with the ball-head anchor; with this threaded rod, the lifting bowl can be temporarily attached to the connector, by screwing the threaded rod into the tapped hole of the connector; is a separate part which is preferably mounted to the module by fasteners; is made of metal, such as steel; is plate-shaped; is mounted in a recess or lowering in the module, preferably at least 5 or 10 millimetre deep; is rectangular in plan; a connector and/or counter-connector at a distance of at least 1 or 2.5 or 3 and/or at most 3.5 or 4 metre from a corner point or longitudinal end or connector or counter-connector at the end of the module and which preferably keep a mutual distance of at least 2 or 3 or 4 metre.

6. One or more of the following may additionally or alternatively apply to the connector: is T-shaped in plan view and/or at least 5 millimetre thick; has a thick and a minimum of 2 or 5 or 10 millimetre thinner thin part, each rectangular in plan; the thick part is closer to the associated side edge of the module than the thin part; a part, such as the thick part, is at least 50 or 100 millimetre wide and/or adapted to support the cone, which can also be called "conical part" or "tapered part"; a part with a width of at least 50 or 100 millimetre and/or a length of at least 100 or 200 or 300 millimetre, for example the thick part, is located straight and/or completely above the side wall or the column and is preferably secured thereto by preferably mechanical fasteners such as screws; a part with a width of at least 50 or 100 or 150 millimetre and/or a length of at least 50 or 100 millimetre,

for example the thin part, is located straight and/or completely above the ceiling plate and is preferably secured thereto by preferably mechanical fastening means, such as screws; has an area of at least 5,000 or 10,000 square millimetres; the part above the ceiling plate is screwed to the ceiling plate with a minimum of 10 mechanical fasteners, such as screws, which insert into individual holes in this part.

7. two modules directly next to each other are alternatively coupled to each other by a separate coupling part of preferably sheet material such as sheet metal, which engages on the two cones of the adjacent connectors of the two definitively placed modules, for which purpose the coupling part is preferably horizontal and/or is provided with two holes into which the cones are fitted closely, e.g. the diameter of the holes is 57 millimetre and/or is at most 2 or 3 or 4 or 5 millimetre greater than the largest diameter, e.g. 54 millimetre, of the cones. This allows fast and accurate work on the construction site. The coupling part bridges both modules in a tensile and compression-resistant direction in the horizontal direction and lies on the connector of the two modules. The coupling part preferably comprises an acoustic decoupling comprising, for example, an acoustically damping material, for example the coupling part consists of two parts or halves, each associated with one of the two modules, and fixed together by the acoustic decoupling, so that the modules fixed to each other are mutually acoustically decoupled.

8. For example, for the purpose of working safely during construction, one or more of the following applies to the blind locking hole and/or the blind coupling hole: accessible from the inside and/or interior space of the module; opens on the side of the surrounding wall or column facing the opposite wall or column of the same module; opens to the inside and/or interior of the module; is made in the wall or column by performing a material or wood removal operation over the entire extent of the locking or coupling hole from the side of the wall or column intended to face the interior space of the module.

9. for the beam at the level of the floor slab of the module, one or more of the following applies: continuous over the entire length of the module; the lower surface of the column rests on the upper surface of the beam, preferably of equal width; is made of laminated wood of which the wood layers are placed vertically and/or in the height direction of the module and the beam; the number of wood layers is at least 30 or 50 or 60; the width of the beam increases in steps on the side facing the interior space of the module, which provides a rebate with a height preferably equal to the thickness of the floor slab and as a result of which the floor slab is supported with its longitudinal edge by the beam; the upper surface of the floor slab and the beam are on the same level; the counter connector is placed against the bottom surface of the beam; the column, beam and/or counter connector are permanently fixed to each other by means of screws or similar fastening pins extending vertically and/or in the height direction of the module; the thickness of all wood layers is a maximum of 6 or 5 or 4 millimetre; there are wood layers, preferably at least 65% or 70% or 40 or 45 of all wood layers, the so-called length layers, of which all or at least 80% or 90% of the wood fibres are located in the longitudinal direction of the beam, and thus extend in the longitudinal direction of the module; there are wood layers, the so-called cross layers, preferably at least 15% or 20% or 10 or 15 of all wood layers, of which all or at least 80% or 90% of the wood fibres are located in the height direction of the beam and thus extend in the height direction of the module; between two cross layers there are at least 8 or 9 or 10 length layers; the cross and length layers form a pattern that repeats at least 3 or 4 or 5 times in width direction of the beam, whereby a pattern is, for example, determined by at least 10 or 12 or 15 wood layers, i.e. at least 8 or 10 or 11 length layers with on both sides each time at least 1 or 2 cross layers; the rebate has a height of at least 100 or 110 and/or at most 120 millimetre and/or equal to the thickness of the floor slab; the rebate has a width, measured parallel to the width of the beam, equal to a minimum of 10 or 15% or 30 or 40 millimetre and/or a maximum of 25% of the width of the beam or 60 millimetre .

[0020] The invention also relates to any combination and permutation of the above individual inventions and/or of one or more individual features of one or more of the above inventions with one or more individual features of one or more other of the above inventions.

[0021] In the following, the invention is further disclosed by way of non-limiting embodiments. Shown is in:

fig. 1- 5 in perspective a general view of modules and their application in a building;
fig. 6-7 a first embodiment of the invention in a perspective view;
fig. 8 the horizontal connector of the first embodiment, in an exploded perspective view;
fig. 9 the vertical connector of the first embodiment, in an exploded perspective view;
fig. 10-17 a second embodiment of the invention in a perspective view;
fig. 18 a schematic view of a detail of the second embodiment during module stacking, in perspective;
fig. 19-21 photographic representations of details of the second embodiment;
fig. 22-23 a detail of fig. 4 or 5;
fig. 2 4-30 an alternative to the connector 6 of fig. 20; and
fig. 31-32 an independent residence within the building, with a gross floor area of 91 and a usable area of 81 square metre.

[0022] Meaning of the reference numbers in the drawing: floor plate 2; ceiling plate 3; side wall 4; connector 6; plaster wall 7; counter connector 8; column 9; beam 10; window or door opening 11; locking pin 12; bail thickening 13; coupling pin 14; blind lock hole 16; blind coupling hole 18; ball head anchor or alternative lifting point 22; cylindrical stump 23; projection 24; horizontal connecting lip 25; horizontal coupling plate 26; coupling part 27; hole 28; acoustic decoupling 29; bore 30; conical bulge or alternative cone 31; lashing eye 32; tapped hole 34; mounting screws 35.

[0023] fig. 1 shows a two-storey building, with per floor a single layer of five modules placed parallel to each other. Each module is designed as a rectangular tube with closed walls with a thickness of at least 100 millimetre , floor and ceiling of CLT, Cross Laminated Timber. The side wall 4 is 140, the floor plate 2 is 120 and the ceiling plate 3 is 80 millimetre thick. The top and bottom surfaces of the floor plate 2 are formed by a 30 millimetre thick wood layer, with three wood layers each 20 millimetre thick in between. The top and bottom surfaces of the ceiling plate 2 are formed by a 30 millimetre thick wood layer, between which there are two wood layers, each 20 millimetre thick. The wood fibres of the thin wood layers run parallel to the longitudinal direction and of the thick wood layers parallel to the width direction of the module.

[0024] fig. 2 shows a single layer of two parallel and closely juxtaposed pairs of sequentially placed modules of FIG. 1. FIG. 3 shows an enlarged detail of FIG. 2. Each module is spaced on its upper face at the two longitudinal edges at a total of six positions, i.e. at the vertices and halfway along the length, some of these positions are indicated by an arrow in fig. 2, equipped with a provision 6, hereinafter referred to as: "connector", for one or more of: lifting the module; horizontal coupling with directly adjacent module; vertically docking with the module directly above it; mounting guide with the module directly above it; changing from lifting device, e.g. lifting bowl or ball-head anchor to mounting device, e.g. vertical coupling pin or cone with threaded rod. The lower surface is provided in a total of six positions, which are vertically aligned and/or correspond to the six positions on the upper surface, with a counter-provision 8, hereinafter referred to as "counter-connector", for cooperating with the coincident connectors 6 of a module directly below it, or the foundation immediately directly below the lowest module, for one or more of: horizontal coupling with directly adjacent module; vertically docking with the module directly below; mounting guide with the module directly underneath. The positions of the blind locking holes 16 and the blind coupling holes 18 are also indicated. Note that the blind locking holes 16 and the blind coupling holes 18 respectively open out on the surface of the side wall facing the outside or the inside of the module 4. In an alternative, not shown, the module is equipped with eight connectors 6 and counter connectors 8, for example in a pattern as shown in Fig. 5.

[0025] Fig. 4 shows a module in a rectangular box shape with open side walls using columns 9 and beams 10. Columns 9 are at the vertices and mid-length and beams 10 are at the top and bottom surfaces. The six connectors and counter connectors, not shown, are in the same positions as the modules of Fig. 2 and coincide with the location of the columns 9.

[0026] Fig. 5 shows a module with one open side wall and one side wall closed by construction timber. Columns 9 and beams 10 are used for the open side wall. By placing two or more modules directly next to each other with one or both side walls open, a living space with a width of two, three or more modules can be created, for example a living room. The location of the eight connectors 6 is schematically indicated in Fig. 5 and coincides with the distribution of the eight columns 9 over the length of the module. The location of the eight counter-connectors 8 is vertically aligned with that of the connectors 6.

[0027] The columns 9 are provided with blind locking holes 16 and blind coupling holes 18. The blind locking holes 16 and the blind coupling holes 18, respectively, open onto the surface of the column 9 facing the outside or the inside of the module, respectively.

[0028] The prismatic column 9 measures 180 millimetre in the width direction and 280 millimetre in the length direction of the module.

[0029] fig. 6-9 show of a first embodiment the attachment of the connector 6 to the module and also how with the connector 6 two modules located directly next to each other are coupled together so that these modules become immobile in horizontal direction relative to each other. For example, fig. 6-9 show the area indicated by the arrow A in fig. 2-3, and this representation applies to all six positions, see the arrows in fig. 2, on the top face of a module, where the connector 6. To this end, two straight locking pins 12 extend vertically downwards from the connector 6 over a minimum length 100 millimetre, in practice of the order of 400 or 600 millimetre or more, from the connector 6. These locking pins 12 are received under the connector 6 over their entire length in the wood of the side wall 4 of the module. To this end, the side wall 4 is provided with two vertical bores. The locking pins are fixed to the wood of the module, either by being glued, chemical bonding, in the bores, or by a mechanical anchorage 13. The mechanical anchorage is achieved by equipping the side wall 4 with a blind locking hole 16, see Fig. 7, in which the bores open out and in which the free ends, the lower ends, of the locking pins 12 project. An oversized nut or a locking plate or the like separate thickening 13, larger than the diameter of the bore, is fixed, as screwed, on these free ends, so that this thickening 13 prevents the locking pin 12 from being pulled up from the side wall 4. The locking hole 16 provides access to the free ends of the locking pins 12 in order to apply the bosses 13 by hand. Thus, the locking pins 12 fixed with the wood ensure the vertical fixation of the connector 6 with the wood of the module. In this way, a module with a weight of, for example, five thousand kilograms can be

safely suspended from the six connectors 6 in order to be lifted by a crane to its final position in the building.

[0030] fig. 8-9 show the connector 6, as used in FIGS. 6-7, in more detail. After the module has been lifted to its final position in the building, the ball head anchor 22 no longer has a lifting function. An upwardly projecting cylindrical stub 23 is then placed around it, forming a receptacle for a cylindrical projection 24 with conical lower end protruding below the lower surface of the side wall 4 of the module to be stacked. The cooperation of stub 23 and projection 24 provides a high accuracy of mutual horizontal positioning of modules stacked directly on top of each other. The horizontal lips 25 are fixed to each other by the horizontal coupling plate 26, whereby the mutual positioning of modules placed directly next to each other is horizontally fixed.

[0031] fig. 10-17 relate to a second embodiment of the connector 6. The main deviations from the first embodiment, see fig. 6-9, are that the ball head anchor 22 can be disassembled and is replaced by a coupling pin 14 after the module is lifted on its definitive place in the building. The coupling pin 14 facilitates the process of stacking the modules on top of each other at their final location in the building and forms part of the vertically mutual anchoring of stacked modules, for instance securing it against being blown up.

[0032] fig. 10 and 11 show from different viewing directions a portion of two modules which have been lifted to their final position in the building side by side and anchored to each other via the connectors 6. The ball head anchors 22 are still in place.

[0033] fig. Fig. 12 shows in the view of Fig. 10 a next stage during construction in which the ball head anchors 22 have been replaced by straight coupling pins 14, which project vertically straight up for a minimum length of 100 millimetre from the connector 6. In fig. 12 are located at the free ends of the coupling pins 14, separate coupling thickenings 15. These coupling thickenings 15 are only placed after a next module has been placed on top. These coupling thickenings 15 have the same function as the locking thickenings 13 on the locking pins 12.

[0034] The locking boss 13 and the coupling boss 15 provide a hooked edge that hookingly engages the material of the sidewall 4 around the bore 30, see e.g. Fig. 19, and is provided, for example, by a retaining ring which is fitted snugly onto the locking pin 12 and coupling pin 14, respectively and is held back by a subsequently screwed on nut.

[0035] The completed construction phase of stacking a next module on a final module is shown in Figs. 13-17. An earlier moment during the stacking of a next module is schematically shown in Fig. 18.

[0036] Fig. 13-14 show of a stacked module only the counter-connector 8; the rest of the stacked module is omitted. The coupling pin 14 is passed through a vertical bore, see e.g. fig. 18, in the mating connector 8 and extends 100 millimetre vertically upwards from the mating connector 8 over a length of at least further through a bore in the wood of the stacked module.

[0037] Fig. 15 shows in a front perspective view of a building the area indicated by the arrow B in fig. In 1. In this area the corners of four modules placed next to and on top of each other come together. fig. 16-17 show a more oblique perspective from two viewing directions. In Fig. 17, the side walls 4 of the lower two modules are partially omitted to show the locking pins 12 .

[0038] Fig. 16-17 show the blind coupling holes 18 which have a function like that of the blind locking holes 16, one of the blind locking holes 16 can be partially seen in Fig. 16. Note that the blind locking holes 16 and the blind coupling holes 18, respectively, open out on the surface of the side wall 4 facing the outside or the inside of the module. The counter connector 8 is equipped with a lashing eye 32 with which the module can be secured to the loading surface of a truck.

[0039] The connector 6 and counter connector 8 are located vertically one above the other in the building and have a spacing of at most 50 or 100 millimetre, preferably, they rest directly on each other, optionally through the interposition of an intermediate layer, for instance felt or similar acoustic damping material.

[0040] Fig. 18 shows a moment during the module stacking phase. The coupling pin 14 projecting vertically upwards from the connector 6 on the top surface of the lower module is aligned with a straight vertical bore 30. The counter connector 8 on the bottom surface of the module to be stacked, which bore 30 continues vertically straight into the side wall 4 of the module and terminates in a blind coupling hole 18. The bore 30 has a conical hole widening over a first longitudinal portion, from the lower end, to facilitate insertion of the coupling pin 14. The coupling pin 14 has at its base connecting to the connector 6 a conical boss 31 conforming to the conical hole extension of the bore 30 to fit closely together. As soon as the six coupling pins 14 of the lower module insert into the bores 30 of the floating module above it, suspended from the crane, the coupling pins 14, due to their bending stiffness, help to keep the floating module immobile in the horizontal direction, which facilitates the precise stacking of the modules even at high wind speeds.

[0041] Fig. 19 shows a photograph of a blind coupling hole 18, into which the bore 30 opens from below, which runs vertically straight up from the bottom surface of the mating connector 8, and thus from the bottom surface of the module, inside the side wall 4. The blind locking hole 16 is similar in design, however, at the blind locking hole 16, the straight, vertical bore comes from above.

[0042] Fig. 20 shows of the connector 6 a horizontal steel plate with a single horizontal connecting lip 25 projecting laterally from the side wall 4 of the module, a tapped hole 34 for interchangeably fixing a lifting point 22 or coupling pin 14, and three parallel rows of seven holes each with a screw 35 inserted in each hole, which screws 35 are screwed into the module and are intended to transfer horizontal forces between the modules.

[0043] Fig. 21 shows, in deviation from fig. 20, a double horizontal connecting lip 25 and the single connecting lip 25 of fig. 20 fits exactly in the space between them. The double connecting lip 25 is mutually positioned so that the single connecting lip falls between the double connecting lip. The connecting lips 25 are then screwed together by the horizontal connecting plate 26, see e.g. fig. 14 or 15.

[0044] The connector 6 in figs. 20 and 21 is recessed by being placed in a recess made from above in the module so that the top surface of the connector 6 is level with the top surface of the surrounding wood of the module.

[0045] Fig. 22 and 23 show in detail in perspective and end view the connection of the column 9 and the beam 10 at the level of the floor plate 2 of the module of figs. 4 and 5. The beam continues uninterrupted over the entire length of the module and the lower surface of the column 9 rests on the upper surface of the beam 10. The width of the beam 10 increases in steps on the side facing the interior of the module, providing a rebate with a height equal to the thickness of the floor plate 2 and whereby the longitudinal edge of the floor plate 2 is supported by the beam 10, while the top surface of the floor plate 2 and the beam 10 are at the same level. The counter connector 8 is placed against the bottom surface of the beam 10. The column 9, beam 10 and counter-connector 8 are permanently fixed to each other by means of screws or similar fastening pins extending vertically and/or in the height direction of the module.

[0046] Fig. 24-30 show an alternative connector 6. The horizontal separate coupling part 27 is arranged after the modules to be coupled together have been placed definitively. In the holes 28, the cones 31 are fitted closely. The coupling part 27 consists of two halves which are fixed to each other by an acoustic decoupling 29.

[0047] Fig. 31-32 show a top view and partly broken away perspective, respectively, of an independent house within the building. The dwelling is provided by two modules placed side by side in register, the facing sides of the modules being open so that the floor and ceiling continue between the modules and the interior space of the two modules forming an uninterrupted living space having the width of two modules. In that living space, the columns 10 stand on the separation between the two modules, see fig. 4-5. With the aid of plaster walls 7, the living space is divided into separate living spaces, for example a bedroom, living room, bathroom, toilet, storage cupboard. In each case, two columns 10 are located directly next to each other, from one module and the other. There is therefore no constructive side wall between the modules 4. The front and rear walls have window and door openings.

[0048] The features disclosed herein can be individually taken together in any other conceivable combination and permutation to provide an alternative of the invention. Also included are technical equivalents and genuses or generalizations of the disclosed measures. A measure of an example is also generally applicable within the scope of the invention. A feature disclosed herein, e.g. of an example, can readily be generalized for inclusion in a general definition of the invention, e.g. found in a patent claim.

Claims

1. Building, such as apartment building, which is constructed from wooden prefab modules with a load-bearing construction of wood such as coniferous wood, each defining a spatial cell, wherein the load-bearing construction of the sides of each module comprises laminated wood, with a thickness of preferably minimal 10 centimeter; and with:

   - each module is designed as a rectangular elongate tube and provides a living space;
   - the modules are applied next to each other and stacked on top of each other, so that two or more floors are realised;
   - each module has a rectangular base, a rectangular floor plate and rectangular side walls or columns extending upwards from the floor supporting the rectangular ceiling plate of the module;
   - the sides of stacked modules are mutually aligned;
   - all modules have the same length orientation.

2. Building according to claim 1, all modules are equipped on the top surface in four locations which are spaced from each other with a separate, preferably metal, provision (6), for example connector, fixed to the wood of the supporting construction, for vertical coupling with the module directly on top to prevent upward movement of the module directly on top, the arrangement comprising a pin-shaped member (14) projecting above the associated module which is inserted from below into the wood of the supporting structure (4, 9) of the module directly on top, projecting into a coupling hole (18) which opens out to the surface of the timber of the load-bearing structure (4, 9) facing the inside of the module and is spaced above the top surface of the floor plate (2) and is fixed by fixing means (15) relative to the wood of the load-bearing structure (4, 9) of the module directly on top of it.

3. Building according to claim 2, wherein the pin-shaped member (14) has a boss (31) which projects with tight fit into a part (8, 4, 9) located on the module directly on top of it, preferably for mutually lateral displacement of the module and the module directly on top of it.

4. Building according to any of claims 1-3, all modules are equipped on the top surface with a separate,

preferably metal, provision (6) fixed to the wood of the load-bearing structure, for example connector, for horizontal coupling with the module immediately adjacent, to prevent lateral movement of the module immediately adjacent, which provision (6) comprises a coupling part (25, 27) projecting laterally outside the module and towards the module immediately adjacent, with which these modules are fixed together tensile and compression-resistant in horizontal direction and which bridges these modules.

5. Building according to claim 4, the coupling part (25, 27) comprises:
lips (25) integrated with the provision (6), which via a separate fixation (26) fix the modules to each other, or

- a separate part (27) with holes (28) into which tightly fit upward projections (31) which are rigid with the provision (6).

6. Building according to any of claims 2-5, all modules are fitted on the top face with at least four or six of said provisions (6) distributed over the four corners and along the length of the two sides between the corners of the module and these features of all modules next to and above each other are mutually aligned so that the locations correspond to each other.

7. Building according to claim 6, the number of said provisions (6) is at least eight, distributed as shown in Fig. 5 and corresponding in location between the modules next to and above each other.

8. Building according to any one of claims 2-7, the provision (6) includes a horizontal plate and preferably one or more of: a tapped hole, being an internally threaded hole to which an upward projection (14, 31) is screwed; at least two parallel rows of holes, with at least three holes per row, with a fastening means, such as a screw, inserted in each hole, which screws are screwed into the structural wood of the module and are intended, for example, to transfer horizontal forces between the modules; is mounted in a recess or lowering in the module; is rectangular and/or T-shaped in plan view.

9. Building according to claim 8, the provision (6) is one or more of: minimally 5 millimetre thick; has a thick and a minimum of 2 or 5 or 10 millimetre thinner thin part, each rectangular in plan view; the thick part is closer to the associated side edge of the module than the thin part; a portion, such as the thick part, is at least 50 or 100 millimetre wide and/or adapted to support an upward projection (14, 31) such as the cone, which may also be termed "conical portion" or "tapered portion"; a part with a width of at least 50 or 100 millimetre and/or a length of at least 100 or 200 or 300 millimetre, for example the thick part, is located straight and/or completely above the side wall or the column and is preferably secured thereto by preferably mechanical fasteners such as screws; a part with a width of at least 50 or 100 or 150 millimetre and/or a length of at least 50 or 100 millimetre, for example the thin part, is located straight and/or completely above the ceiling plate and is preferably secured thereto by preferably mechanical fastening means, such as screws; has an area of at least 5,000 or 10,000 square millimetres; the part above the ceiling plate is screwed to the ceiling plate with a minimum of 10 mechanical fasteners, such as screws, which project into individual holes in this part.

10. Building according to any of claims 2-9, in the provision (6) is the horizontal coupling with the module immediately next to it and the vertical coupling with the module integrated directly on top of it integrated and optionally integrated therein one or more of: mounting guide with the module directly above it; changing from lifting device, e.g. lifting bowl or ball-head anchor, to mounting device, e.g. vertical coupling pin or cone with threaded rod; lifting the module.

11. Building according to any of 1-10, for the beam at the level of the floor slab of the module, one or more of the following applies: continuous over the entire length of the module; the lower surface of the column rests on the upper surface of the beam, preferably of equal width; is made of laminated wood of which the wood layers are placed vertically and/or in the height direction of the module and the beam; the number of wood layers is at least 30 or 50 or 60; the width of the beam increases in steps on the side facing the interior space of the module, which provides a rebate with a height preferably equal to the thickness of the floor slab and as a result of which the floor slab is supported with its longitudinal edge by the beam; the upper surface of the floor slab and the beam are on the same level; the counter connector is placed against the bottom surface of the beam; the column, beam and/or counter connector are permanently fixed to each other by means of screws or similar fastening pins extending vertically and/or in the height direction of the module; the thickness of all wood layers is a maximum of 6 or 5 or 4 millimetre; there are wood layers, preferably at least 65% or 70% or 40 or 45 of all wood layers, the so-called length layers, of which all or at least 80% or 90% of the wood fibres extend in the longitudinal direction of the beam, and thus in the longitudinal direction of the module; there are wood layers, the so-called cross layers, preferably at least 15% or 20% or 10 or 15 of all wood layers, of which all or at least 80% or 90% of the wood fibers extend in the height direction of the beam and thus in the height

direction of the module; between two cross layers there are at least 8 or 9 or 10 length layers; the cross and length layers form a pattern that repeats at least 3 or 4 or 5 times in width direction of the beam, whereby a pattern is, for example, determined by at least 10 or 12 or 15 wood layers, i.e. at least 8 or 10 or 11 length layers with on both sides each time at least 1 or 2 cross layers; the rebate has a height of at least 100 or 110 and/or at most 120 millimetre and/or equal to the thickness of the floor slab; the rebate has a width, measured parallel to the width of the beam, equal to a minimum of 10 or 15% or 30 or 40 millimetre and/or a maximum of 25% of the width of the beam or 60 millimetre.

12. A method for assembling the building according to any of claims 2-11, wherein the modules are placed next to and on top of each other, wherein during the method a module to be stacked is stacked on top of an already definitively placed module, the module to be stacked is suspended from the hoisting cable of the crane by its provisions (6) only.

13. A prefabricated module for the building according to any one of the preceding claims.

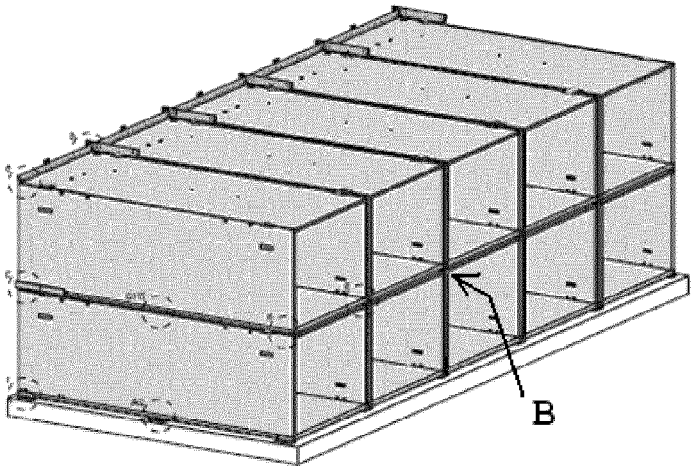


Fig. 1

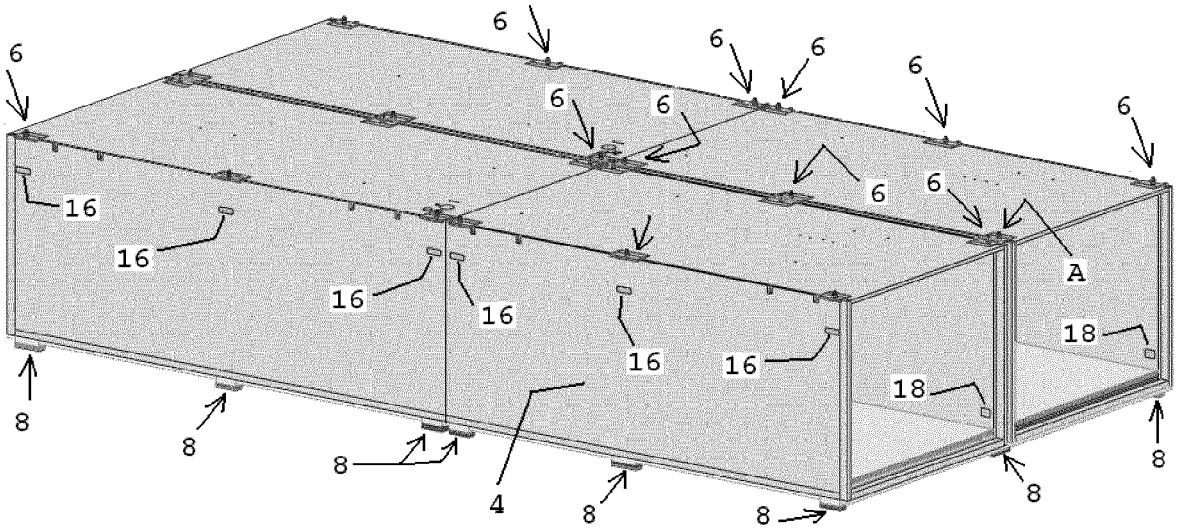


Fig. 2

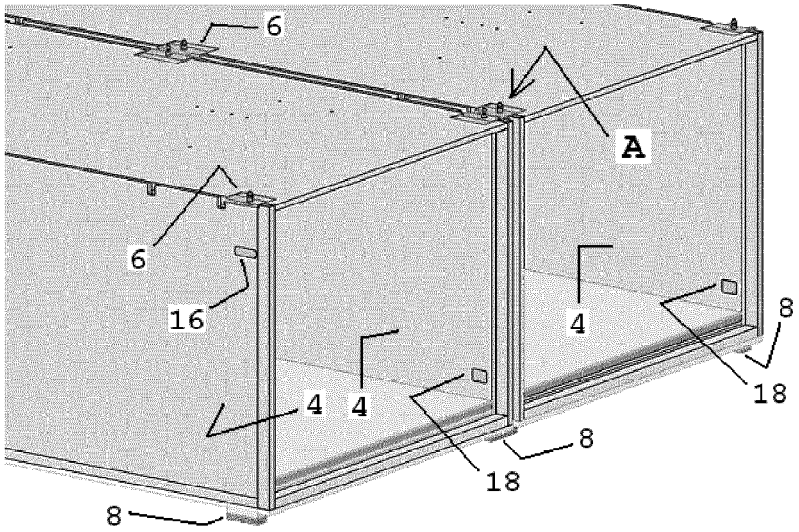


Fig. 3

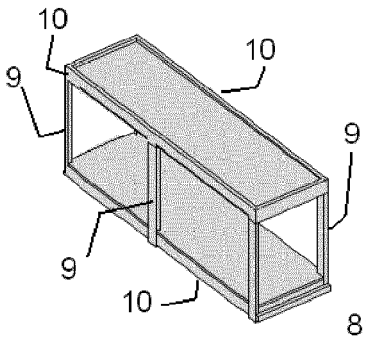


Fig. 4

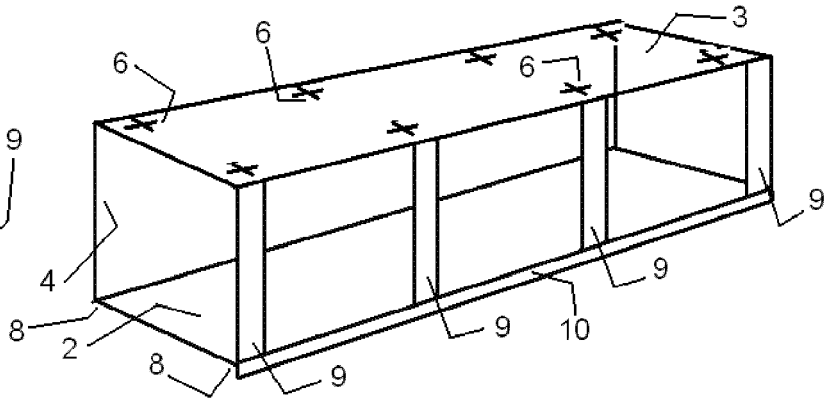


Fig. 5

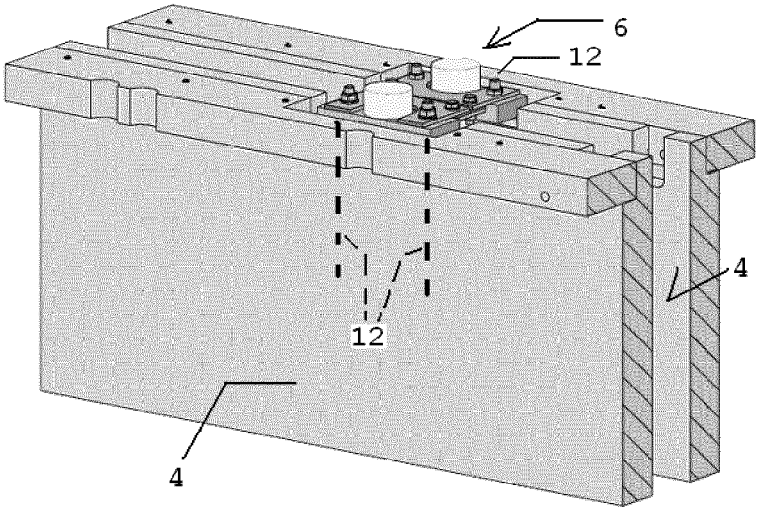


Fig. 6

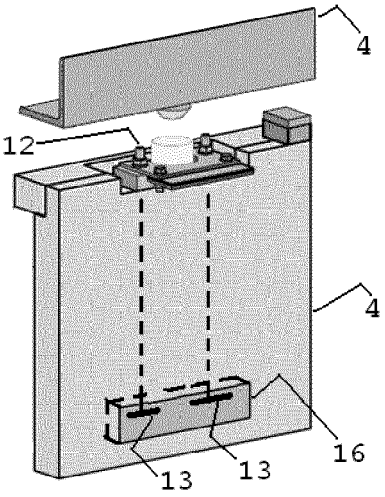


Fig. 7

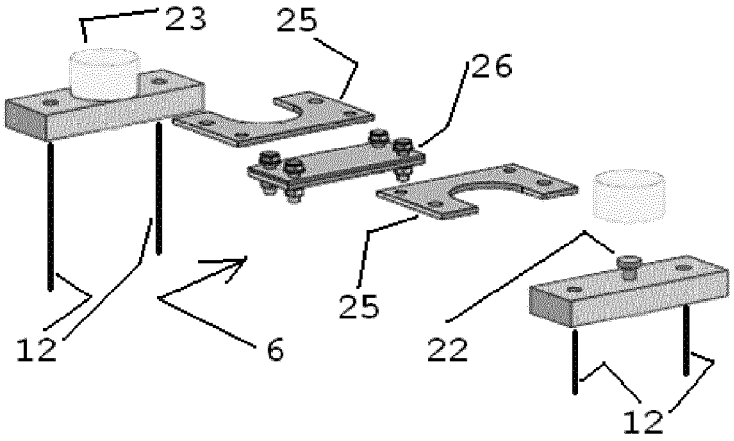


Fig. 8

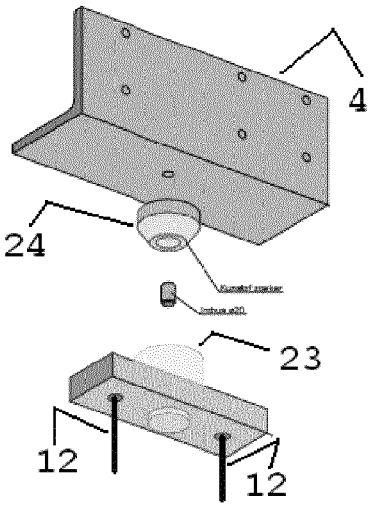


Fig. 9

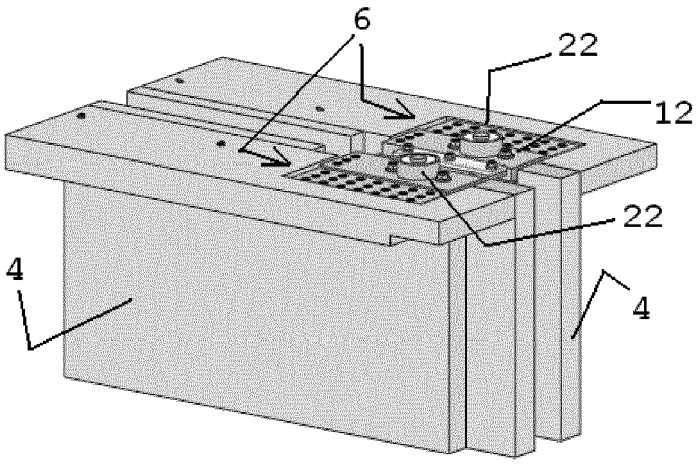


Fig. 10

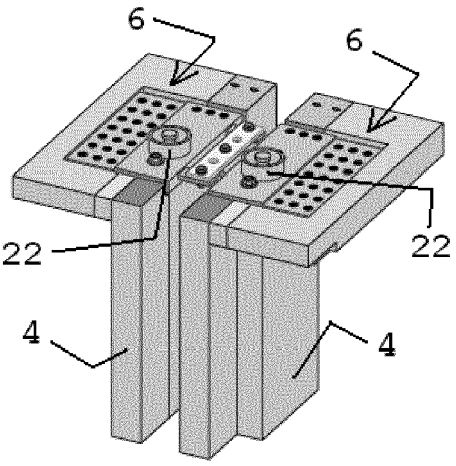


Fig. 11

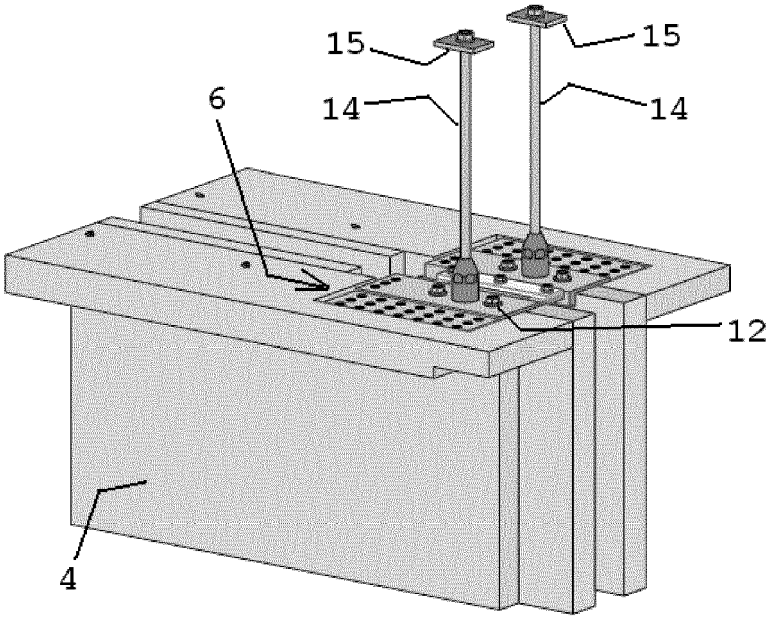


Fig. 12

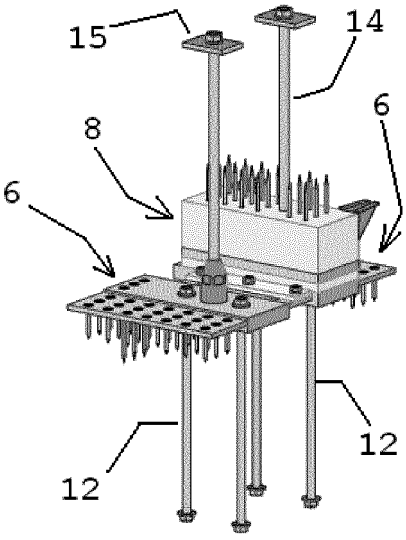


Fig. 13

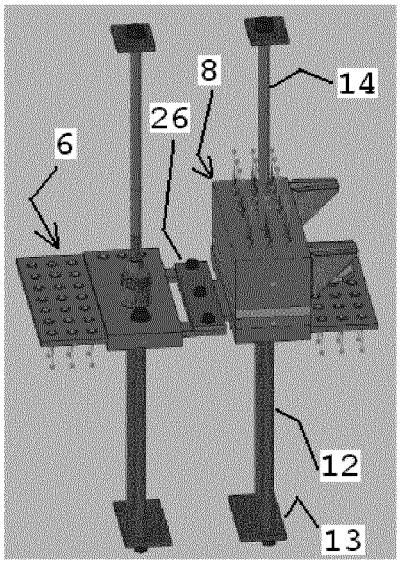


Fig. 14

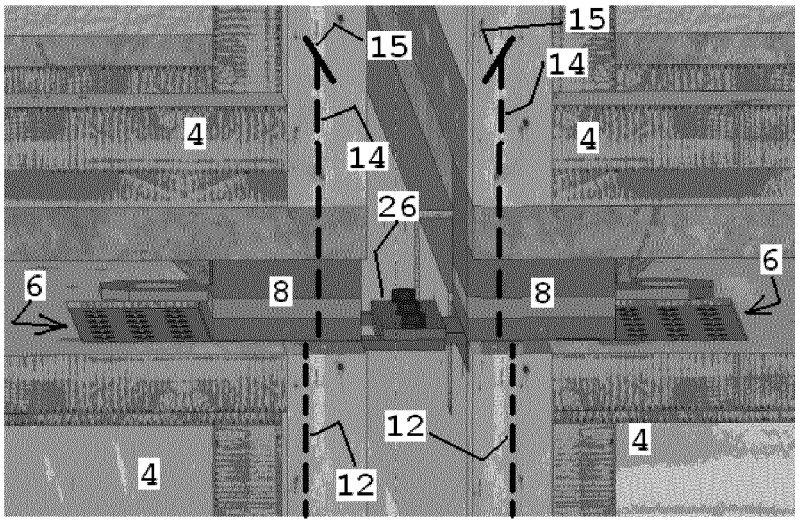


Fig. 15

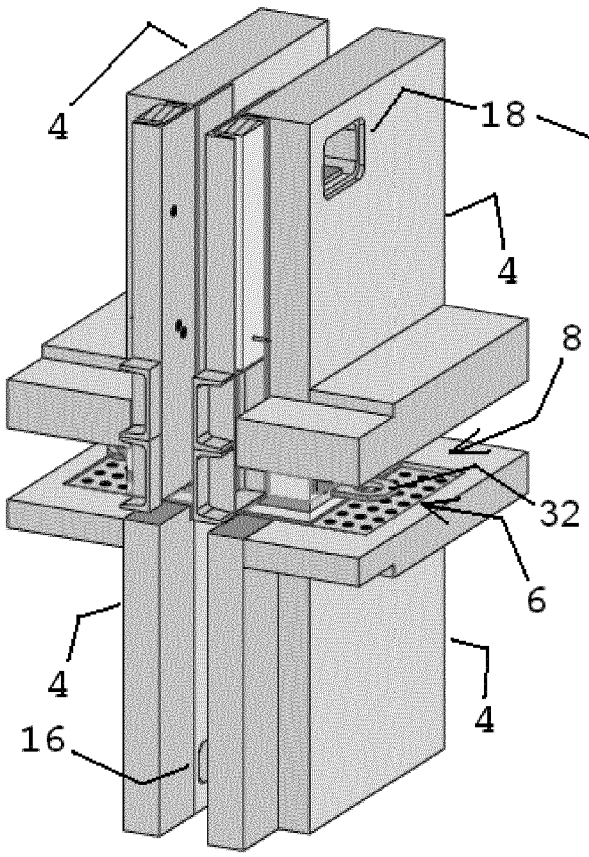


Fig. 16

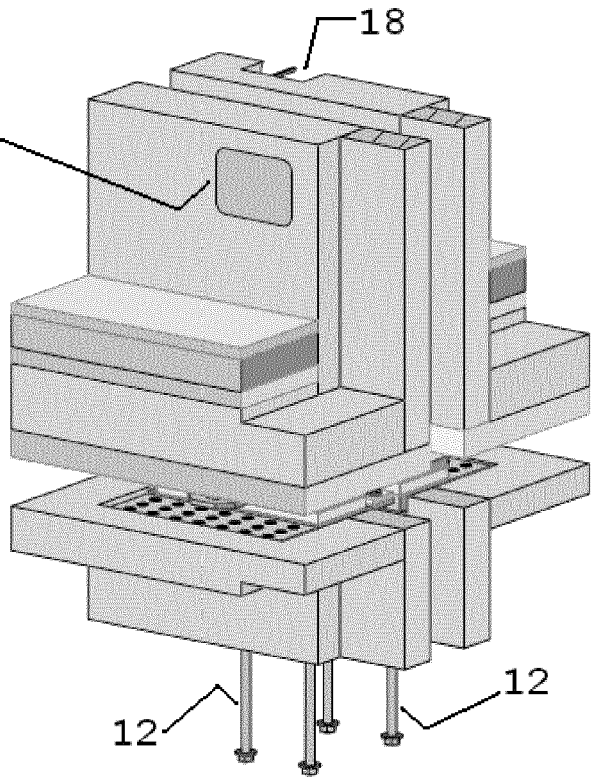


Fig. 17

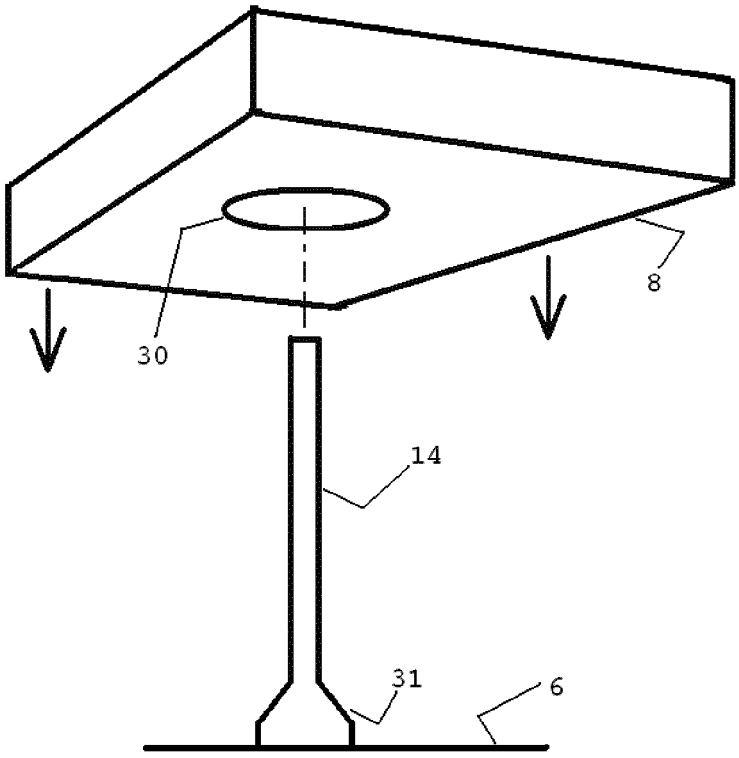


Fig. 18

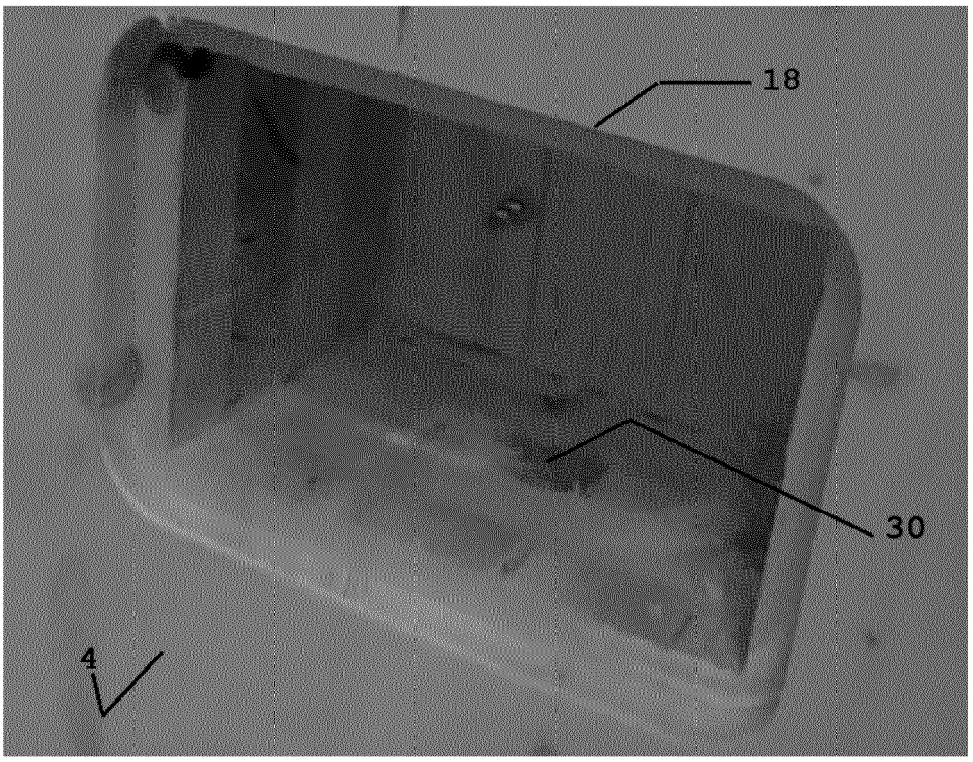


Fig. 19

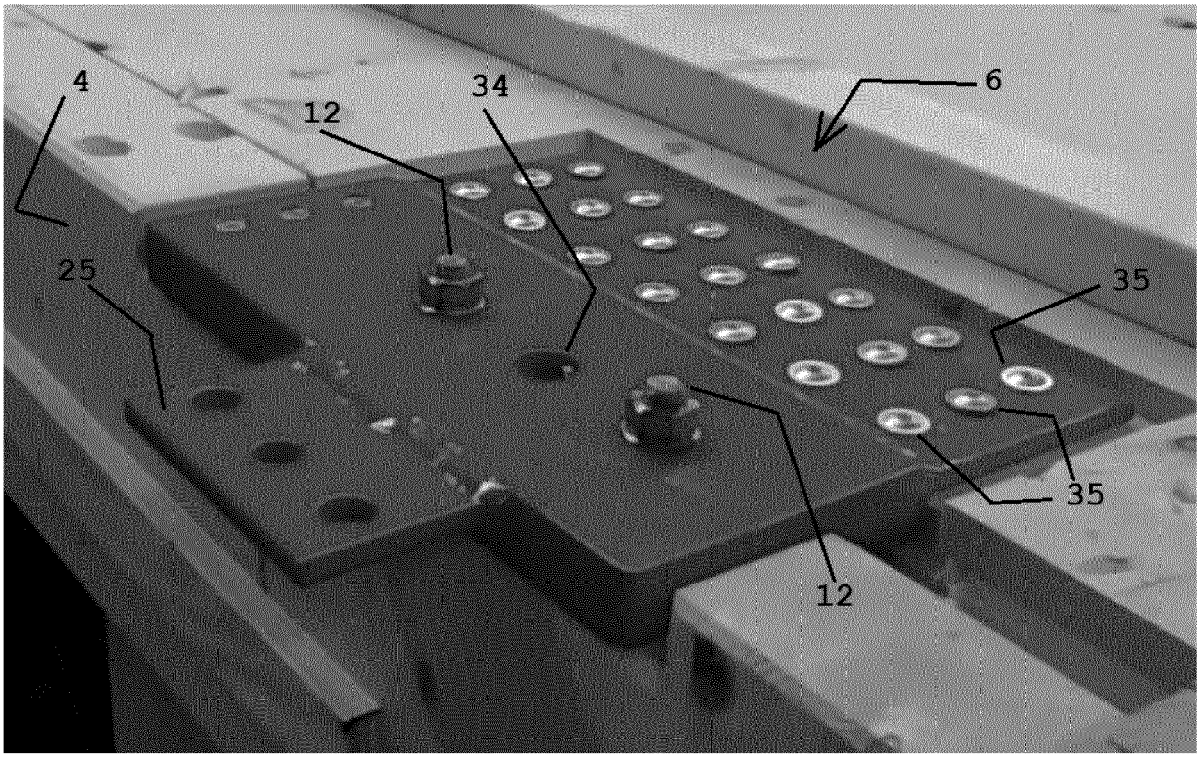


Fig. 20

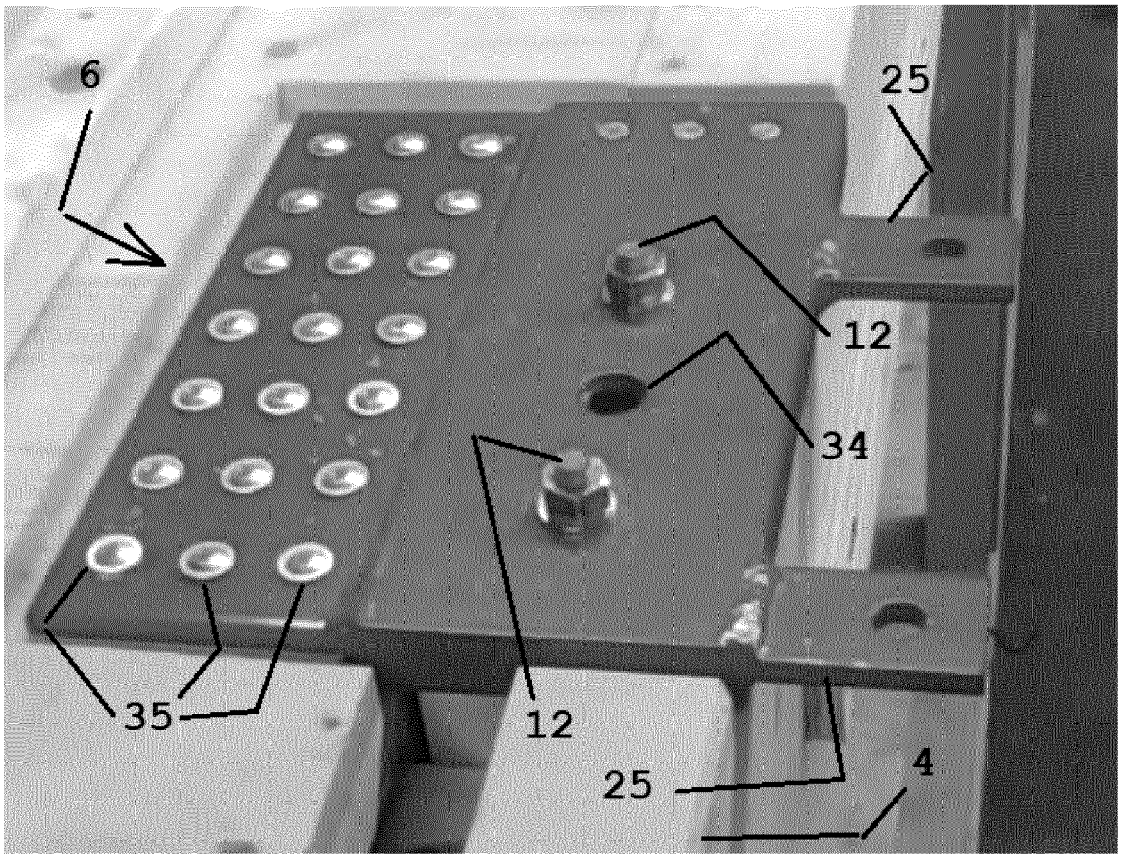


Fig. 21

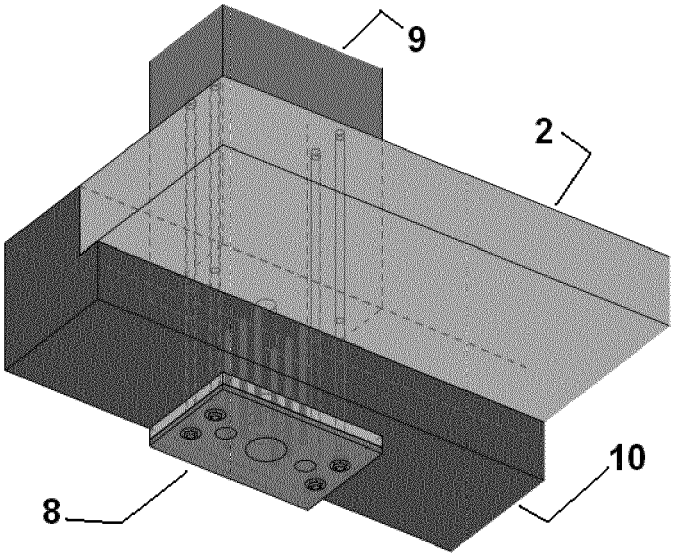


Fig. 22

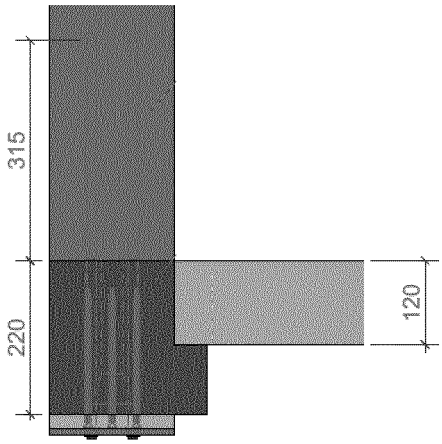


Fig. 23

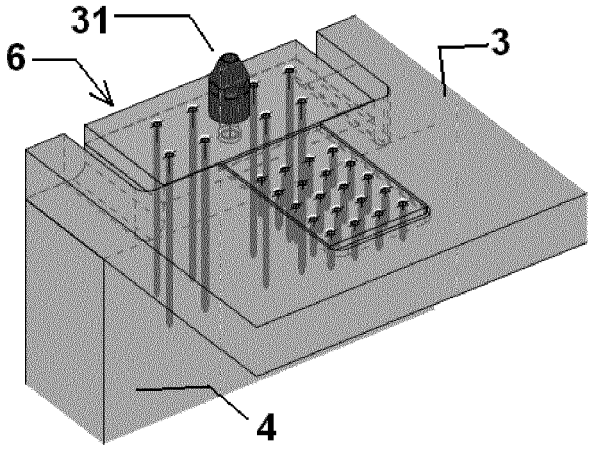


Fig. 24

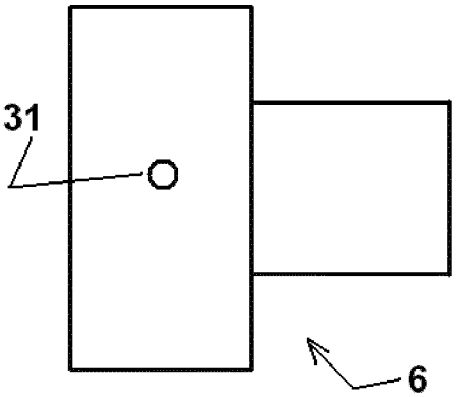


Fig. 25

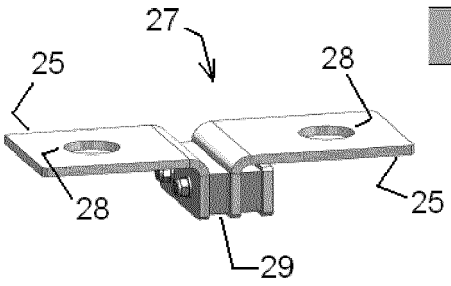


Fig. 26

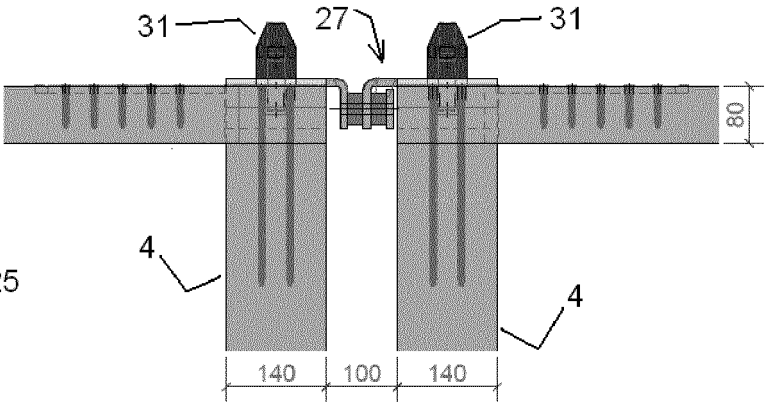


Fig. 27

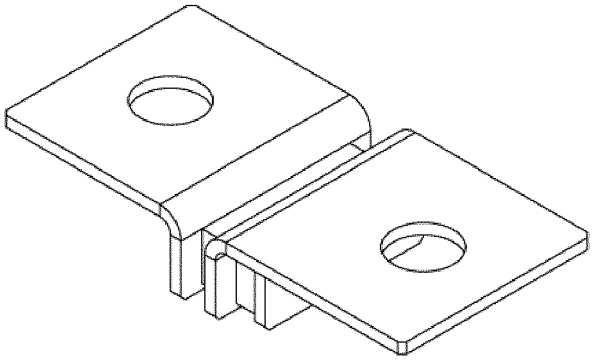


Fig. 28

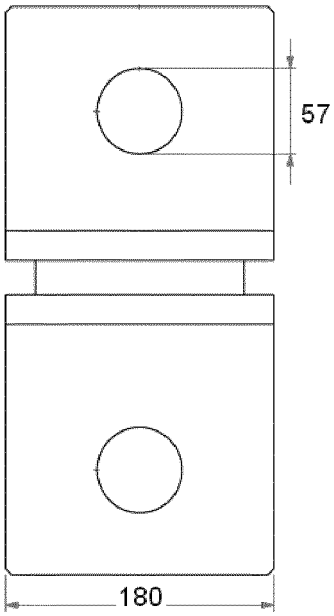


Fig. 29

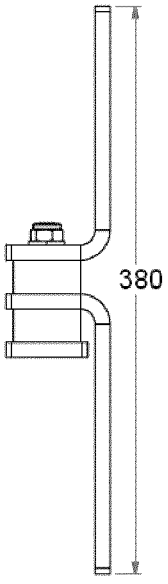
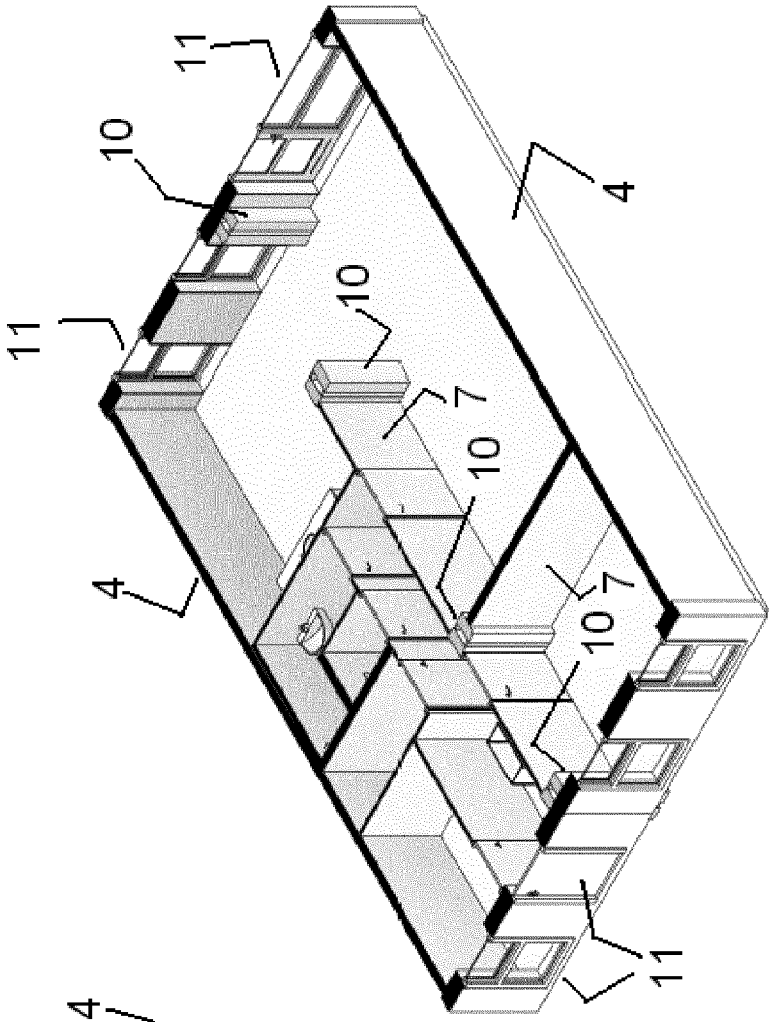


Fig. 30


11
10
11
4
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7
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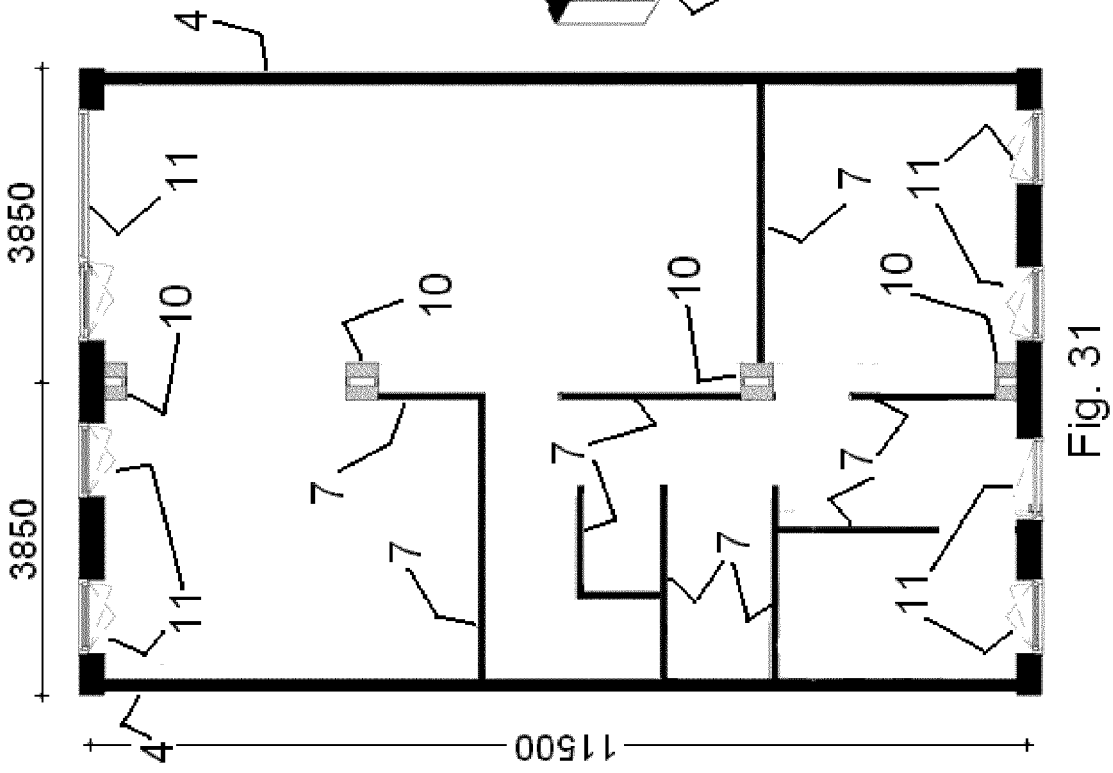
7
10
4
11

Fig. 32


4
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3850
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11500

Fig. 31

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EUROPEAN SEARCH REPORT

Application Number
EP 22 17 7694

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E04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	30 September 2022	López-García, G

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